Weather

Appendix B

To understand the interactions between weather and terrain and to work effectively with the staff weather officer (SWO), the terrain analyst must have a basic knowledge of weather phenomena and weather support procedures. This appendix discusses weather and weather-related factors that may affect military operations.

In addition to terrain, the battlefield environment includes atmosphere (weather), battle-induced contaminants (man-made weather), background signatures, and illumination (both natural and man-made). The terrain analyst, intelligence analyst, and United States Air Force weather personnel work together to integrate these environmental factors with terrain to determine their net effects on mobility and weapons usage. While weather effects on personnel and tactics are specifically an intelligence function, the same environmental phenomena also affect topographic engineer concerns. Therefore, analysis of factors should be a joint effort between topographic engineer, intelligence, and USAF weather personnel. The analyst should have a general knowledge of weather phenomena and its interaction with terrain. The analyst should also know how to get and use weather information. Since equipment and procedures change frequently, analysts should get specific information from the unit involved about effects of the weather on unit equipment and operations.

TYPES OF WEATHER INFORMATION

The three groups of weather information are observations, forecasts, and climatology. Units use observations and forecasts in support of current operations, while they use climatology for long-range planning.

Weather Observations

Weather observations are reports of actual weather conditions existing at a specific location at a given time. Observations are determined visually, with instruments, or both. Terrain analysts will base much of their analysis on current weather observations, since weather information can change very quickly. For this reason, units must also keep observations current. The SWO generally receives weather observations in codes comprised of abbreviations, numbers, letters, and symbols. Codes are used to simplify and speed transmission, not because of classification. The USAF weather personnel can explain the codes used in a given area.

The SWO can obtain observations taken by USAF weather observers, Army personnel in the Forward Area Limited Observation Program (FALOP), artillery meteorology (ARTYMET), and domestic and foreign weather services.

Unfortunately, weather observations are not always available, nor do they always contain the weather parameters of interest. However, the weather forecaster can forecast the present weather at a given location for which observations are not available. This forecast is called a "nowcast"; the complexity of the meteorological situation and the forecaster's knowledge of past conditions at that location determine its accuracy.

Weather Forecasts

SWOs usually base weather support to current operations on observed current weather and on weather forecasts. Weather forecasts are predictions of future weather for a specific period at a specific location or area. Forecast accuracy depends on the time range being forecast, the complexity of the meteorological situation, and the amount and quality of data available. Forecasts for longer time ranges are more general in nature and less accurate than those for 24 hours or less. Forecasts longer than a week are rarely very accurate because of our limited knowledge of how the weather operates. Thus, forecasters usually base long-range forecasts on climatology, a statistical summary of usual weather conditions for a given location and time of the year.

When possible, analysts should present observed weather along with forecast weather information. This lends credence to the forecast and gives the commander a sense of the reliability of the forecast. Weather forecasting is not an exact science, and not all forecasts will be accurate. The SWO will be more confident in the forecast in some situations than in others. Analysts should keep in contact with the SWO in case the forecast changes and should check the progress of the weather observations for their area of operations.

Climatology

Climate refers to the characteristic weather for a given place or area over a specified time. It is usually represented by statistics of weather conditions such as mean values, extreme values, and probability distributions. Commanders use climatology for planning upcoming operations. The SWO should have climatological information for the unit area. If not, he can get it from higher USAF channels. If the unit does not have an SWO, analysts can order climatology data directly from the Air Force under procedures in AR 115-1. Response time depends on whether the data exists and whether it exists in the format needed. Often it will be better to change the request so it can be filled with immediately available data than to demand specific computer-formulated data, which could take more time to get.

Often information from standard climatological summaries will be satisfactory, and units can get it quickly. Examples of such information include normal daily maximum and minimum surface temperatures and normal monthly rainfall amounts. If the supported unit has specific weather sensitivities not covered in standard climatological summaries, USAFETAC can formulate statistics to meet those needs. For example, if a unit has a weapon system that is limited by surface winds of 20 knots or more, the analyst can request statistics on the monthly frequencies of such winds and statistics indicating how often particular hours of the day have winds of 20 knots or more.

Two problems arise from using climatology. First, the specific information may not be available. Observations at that location may never have been taken, or the available observations may not include the specific parameter. Consequently, there is no data base upon which to formulate statistics. Units can usually overcome this shortage by the SWO or USAFETAC estimating weather conditions from nearby stations for which data is available.

Second, too much data is sometimes available. This can create a difficult situation, in which the analyst must be careful not to swamp a commander with useless statistics and unnecessary detail. Thus, the analyst must know which weather conditions will affect the unit's operations and work with the SWO to present a concise summary of pertinent climatology.

WEATHER ELEMENTS

This section describes the application of the more common weather elements to terrain analysis. It contains the basic knowledge needed to work effectively with WETM and intelligence personnel. The information here is not complete; specific information about weather effects on the equipment used by the supported unit must come from that unit itself. Weather effects on terrain can be complex; unfortunately, few tactical decision aids are available. Until further procedures are available, much of the application of weather information will depend on the combined judgement and experience of the terrain analyst, SWO, and intelligence analyst.

Temperature

Temperature, alone or in combination with other weather elements, impacts on many actvities. Extremes of temperature are a discomfort to personnel and can affect equipment and weapons systems. The difference between the temperature of a target and its background is critical to weapons using infrared sighting devices. This section outlines some factors to remember in using temperature information.

Surface temperatures in North America are generally measured in degrees Fahrenheit (^{0}F); elsewhere they are reported in degrees Celsius (^{0}C). Analysts always report upper air temperatures in degrees Celsius. Conversion between the two temperature scales is by the following formulas:

$$F=(9/5x\ C)\ +32$$

$$C=5/9x\ (F-32)$$

Temperature is normally measured at about 5 feet above a grassy surface, with the thermometer shielded from direct sunlight and precipitation. This temperature is not necessarily the same as the temperature just above the surface of the ground. The temperature at grass level can be several degrees higher during the day and several degrees cooler at night. Temperature is dependent on topography, with higher elevations generally being cooler, However, since cold air is denser than warm air, cold air tends to flow into lower areas on nights with light winds.

Analysts must remember that objects are not necessarily the same temperature as the air. Metal objects exposed to sunlight, for example, tend to be hotter than air temperature, due to their absorption of solar radiation. At night they tend to be cooler than the air, because they lose their heat more rapidly by radiation. This can be very important to infrared sensing devices.

Windchill equivalent temperature (WCET), often simply called wind chill, is an approximation of the combined effect of temperature and wind on the exposed human body. Analysts must remember that the air movement causing windchill comes not only from wind but from any movement of the body relative to the air. Riding in an open truck moving at 20 mph in a 10-mph headwind gives a windchill equivalent to a 30 miles per hour wind. Windchill does not apply to equipment. For example, with a -10° F temperature, a battery will perform the same in calm conditions as in a 20-mph wind.

Frozen ground can be critical to trafficability. Frost depth depends on soil type, soil moisture content, type of ground cover, and recent temperature history at the site. Given the same soil and weather conditions, increased soil moisture (up to near the point of saturation) will cause frost to penetrate deeper and faster. Bare soil will normally also freeze faster and deeper than sod-covered areas. Snow cover is an excellent insulator and can cause depth of frost to be shallower than in areas without snow cover. Usually, few observations of frost depth will be available. Furthermore, frost depth cannot be forecast now. Analysts will probably have to depend on their own observations of frost depth.

Temperature climatology information is usually readily available. It is important not to be misled by mean temperature information; extreme temperatures are most important. While there can be no set format for presenting temperature climatology, analysts and SWOs should consider the following example, which gives monthly data on mean daily maximums, mean daily minimums, monthly extremes, and an indication of frequency of some critical values by giving statistics of how many days those values are exceeded:

CATEGORIES*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Extreme maximum	45	48	60	78	92	98	104	104	92	70	60	48
Mean daily maximum	22	32	49	60	75	92	98	98	83	64	43	33
Mean daily minimum	2	11	29	40	55	72	78	80	63	44	24	11
Extreme minimum	128	-22	-2	15	28	53	55	55	26	14	-2	-13
Number of days with temperature less than or equal to 32	31	28	23	5	2	0	0	0	4	14	24	27

* All categories are in degrees fahrenheit

Table B-1. Sample temperature data

Wind

Wind direction is always recorded as the direction *from which* the wind is blowing. Direction is in the sixteen points of the compass or in tens of degrees with north being 360°; east, 90°; south, 180°; and west, 270°. Wind speed is usually in knots (nautical miles per hour, with a nautical mile being 6,076 feet), miles per hour, or meters per second. See Appendix A for conversion tables.

A gust is a rapid fluctuation in wind speed with a variation of 10 knots or more between peak and lull. For example, if the wind were blowing out of the north northeast at a mean speed of 20 knots with gusts to 40 knots, it would be recorded as 030/20G40.

Gust spread is a measurement of wind speed fluctuation normally used only for aircraft operations. The gust spread is the instantaneous difference between peak wind speed and lull wind speed. Since the lull speed is not necessarily the same as the mean speed, the gust spread in the above example could be more than 20 knots.

Wind is highly dependent on terrain and can vary considerably over a few hundred meters. When forecasting for a large area, weather forecasters try to forecast the highest wind condition over that area. Sheltered areas will naturally experience lower wind speeds.

Analysts try to identify wind patterns not only by the general weather situation but also by any influencing terrain factors. Sea coasts and mountainous regions can have unique wind regimes. Analysts and SWOs must especially be aware of narrow mountain gaps that may funnel winds and cause locally high wind speeds.

Wind can act in combination with other weather phenomena. It raises dust which in turn reduces visibility. A very light wind can make fog more dense, but higher winds will disperse fog. Wind breaks temperature invasions. It also speeds the drying of ground and can improve trafficability.

Be careful when examining climatology of wind. Prevailing wind direction is the wind direction that predominates over a given period and is a useful statistic. However, mean wind speed over a period can be very misleading. It could be very windy during daylight hours but almost calm at night and the resulting mean wind speed would be low. However, higher wind speeds during the day could adversely affect operations. Analysts must try to get information on the frequency of occurrence of winds above the critical values for their unit.

Precipitation

Precipitation is very important to trafficability. The effect depends on the type and amount of precipitation, the soil type, surface slope, type and amount of vegetation cover, and soil moisture content before the precipitation fell. Because of this complexity, exact rules are not given. Table 6-3 lists dry and wet season rating cone indices (RCIs) for various USCS soil types. However, the decision to use dry or wet values is, at present, up to the analyst's judgement. Light showers seldom affect trafficability. They may even improve it over sand. However, moderate or greater rain will degrade it.